

Chapter 11: Dependencies and Cascading Effects

Presenter:

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Dimensions of Dependencies

- Internal and External
- Time
- Space
- Source



(Source: FEMA)

(These dimensions may not be independent)



Dependencies

To restore electric service, you need to reopen roads



To restore water service, you need electricity



To restore fuel supplies you need electricity



To reopen roads, you need to restore fuel supplies



Internal and External Dependencies

- Internal Dependency (examples)

- Physical Infrastructure System
- Equipment and Repair Supplies
- Operations Center (and more)



- External Dependency (examples)

- Transportation
- Power
- Communication (and more)

(It is also good to consider who may depend on your system)



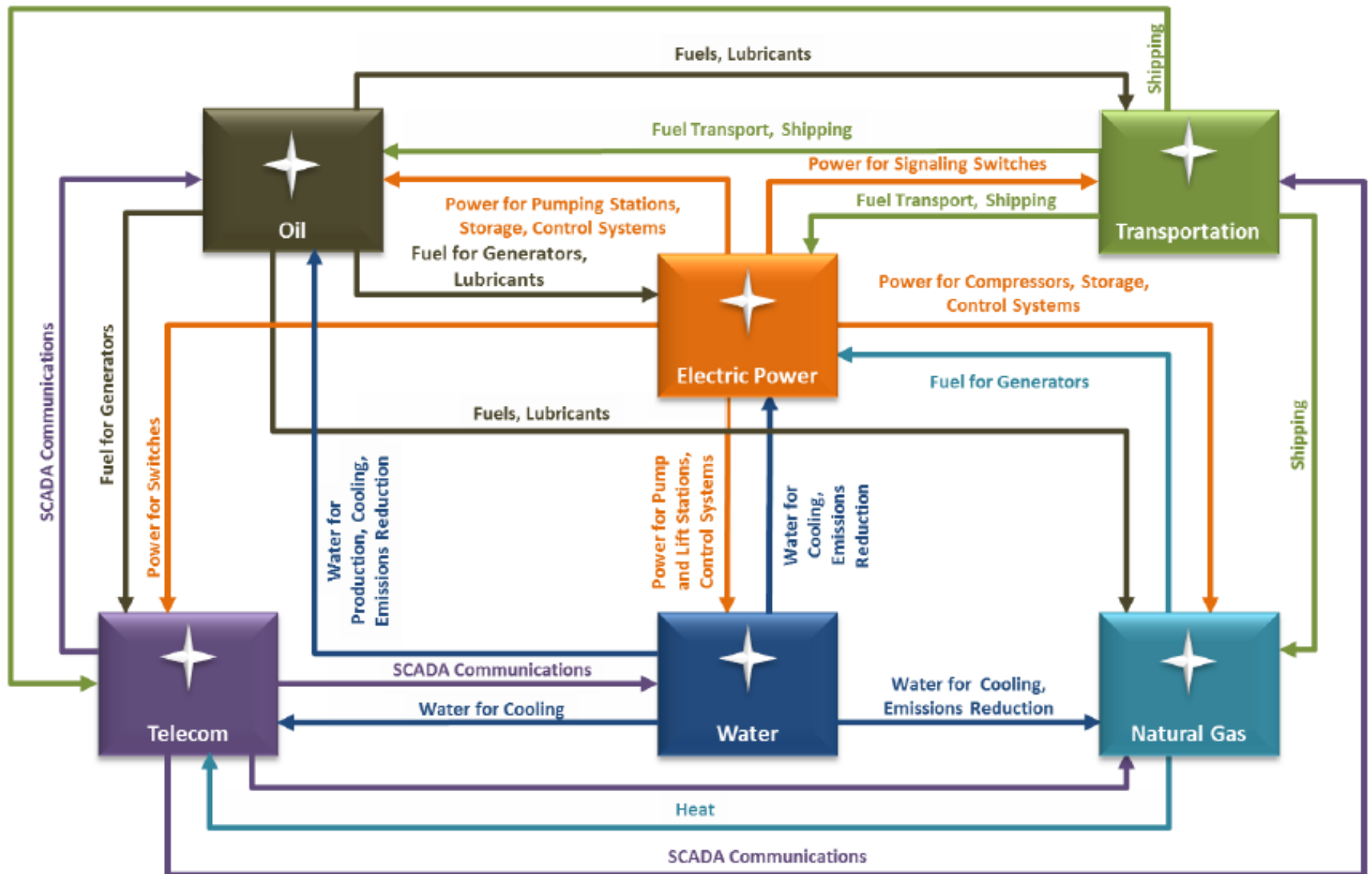
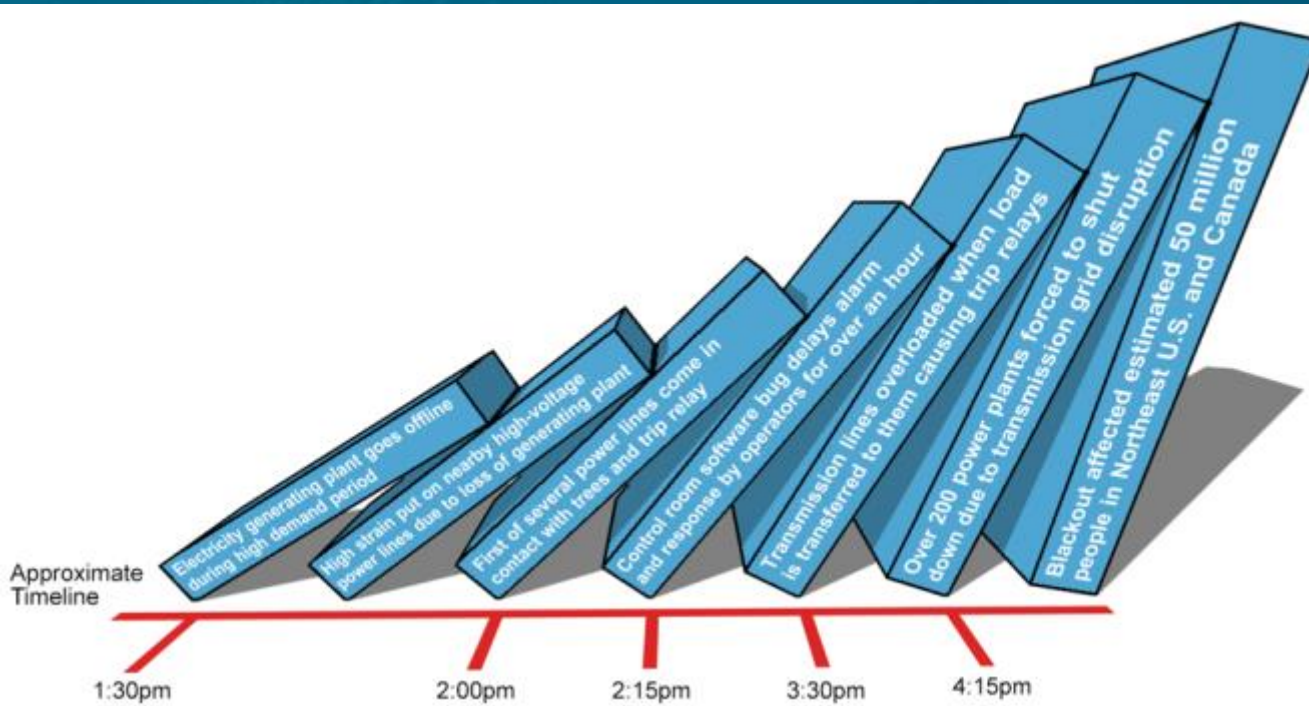


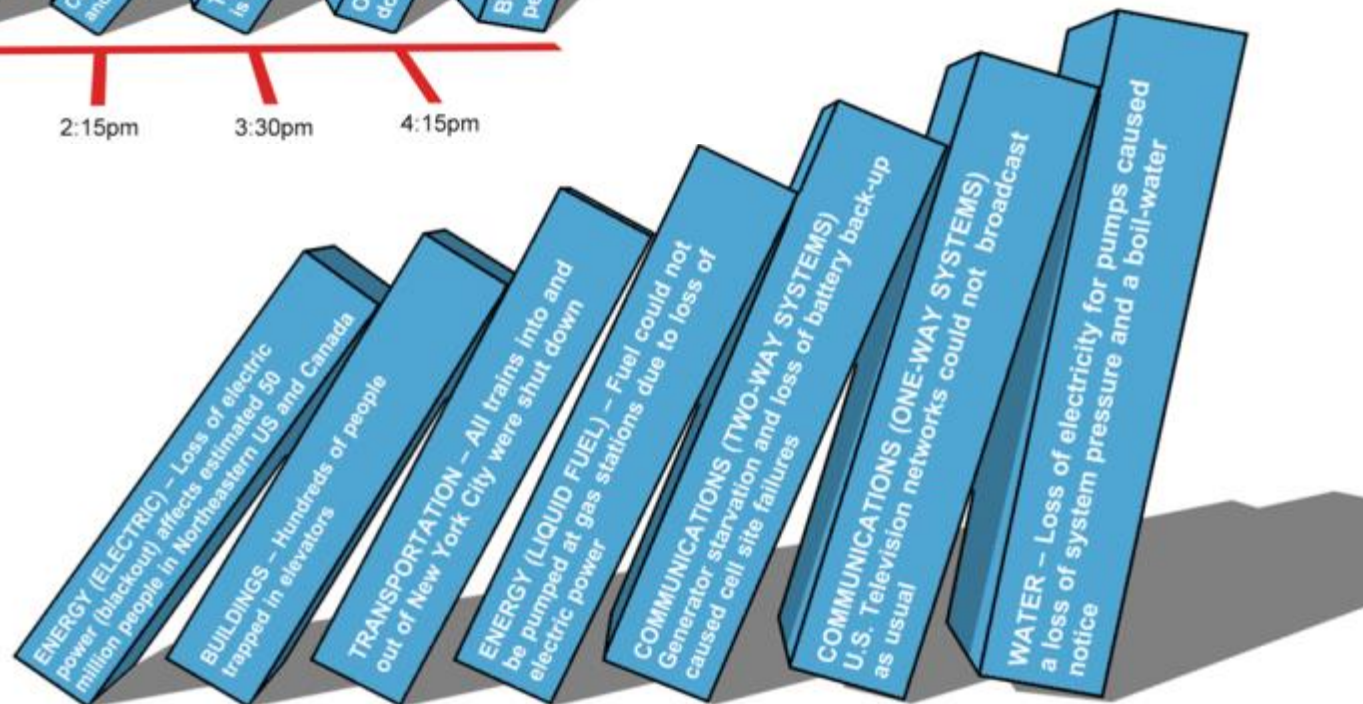
Figure 11-2. Example of external dependency relationships [Adapted and redrawn, Rinaldi et al 2001]

Cascading Effects



Power System
INTERNAL
Cascading
Failure
(2003 NE
Blackout)

Power System
EXTERNAL
Cascading
Failure
(2003 NE
Blackout)



Time Dimension

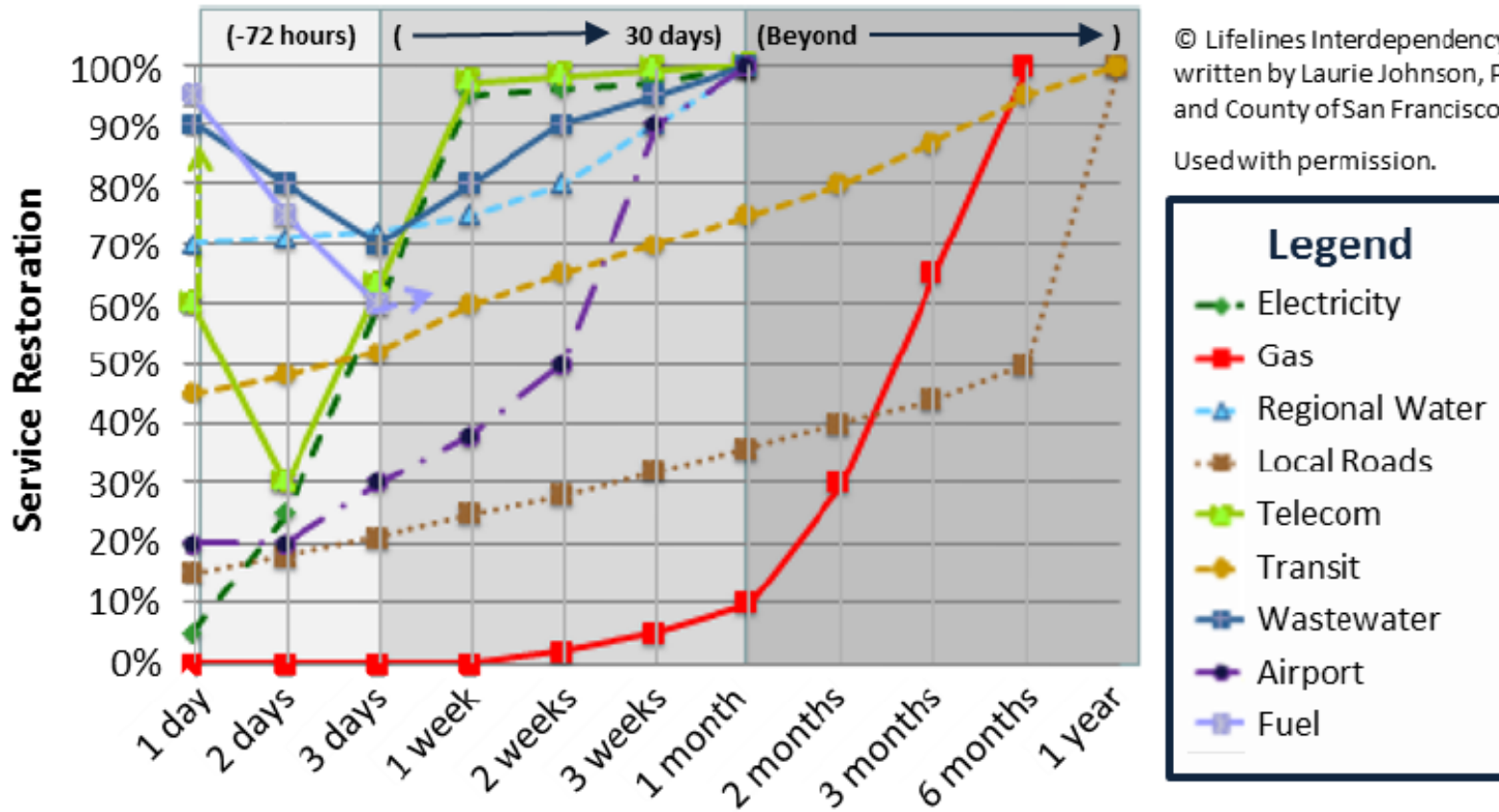
- Recovery Phases
 - Short-Term, Intermediate, and Long-Term
- Dependencies may change from one phase to another
- Performance goals, and restoration sequence and pace are influenced by external dependencies of other infrastructure systems and community needs



(Source: FEMA, 2014)



Restoration Timeframes



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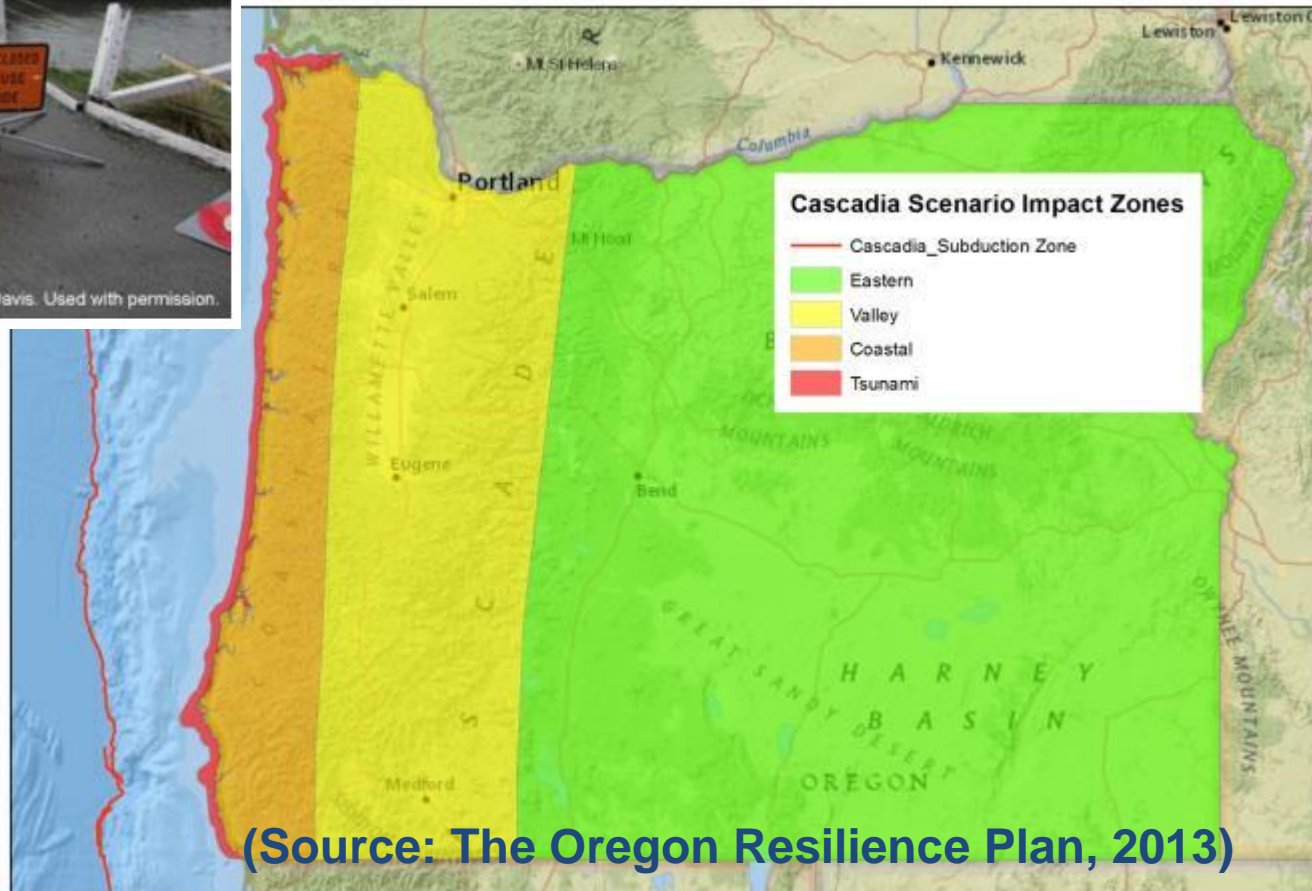
Figure 11-8: Potential service restoration timeframes following a scenario M 7.9 earthquake on the San Andreas Fault estimated in City of San Francisco Study



Space Dimension



Infrastructure Co-location



Earthquake Hazards and Lifelines in the Interstate 5 Urban Corridor: Woodburn, Oregon, to Centralia, Washington

By

E.A. Barnett¹, C.S. Weaver¹, K.L. Meagher¹, R.A. Haugerud¹, Z. Wang², I.P. Madin³,
Y. Wang³, R.E. Wells⁴, R.J. Blakely⁴, D.B. Ballantyne⁵, and M. Darienzo⁶

2009





Photo: Jay Wilson



Source Dimension



(Courtesy of Yumei Wang, DOGAMI)

Additional Examples

- Wholesale Water Supplier
- Wholesale Power supplier
- Centralized Warehouse of A Healthcare System



(Source: FEMA)



Source Dimension



Urban Medical Center

Requires 300,000 gallons per day

Drinking water only 5% of need



300,000 Gallon Bolted Steel Tank, 33' Diameter, 48' Eve Ht.

Source: nationalstoragetank.com

